# *Bell Work*
# *24-April-17*

**Please compute the " –log(7)" using your calculator?**

**What are acids and bases?**

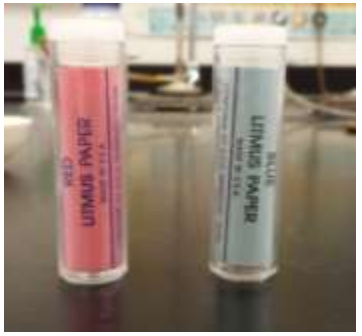
EQ: What bases have you used today and how did they help you?

**Agenda:**
**introduction to Acid Base Chemistry**

Objective:

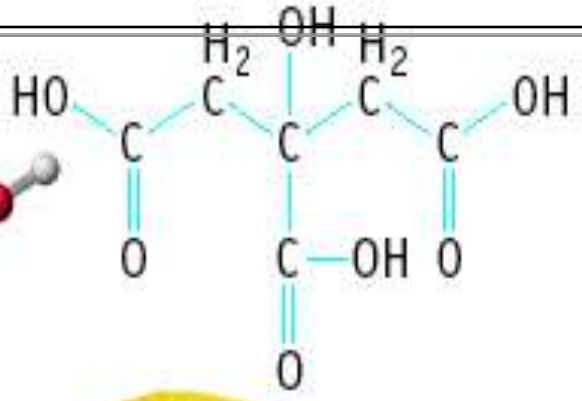
Following the lesson you will be able to name simple acids and bases, know a general definition of an acid, and know how acids and bases taste

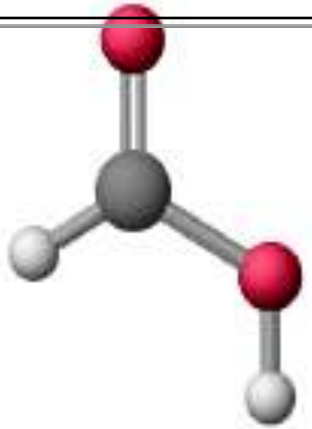
# *Visual Introduction to Acid Base Chemistry*

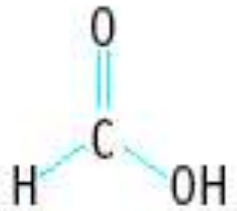



**NaOH (aq) + HCl (aq)→**

# Acid and Bases



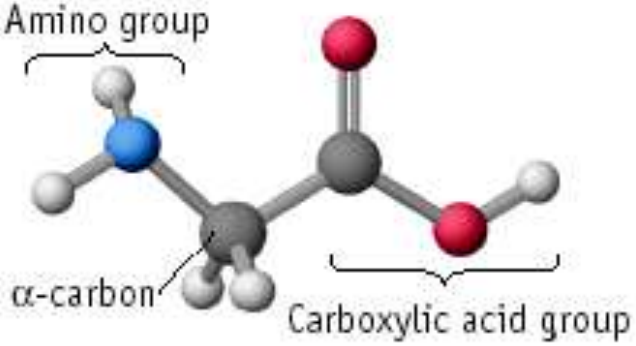






The tartness of lemons and oranges comes from the weak acid citric acid. The acid is found widely in nature and in many consumer products. *(Charles D. Winters)*

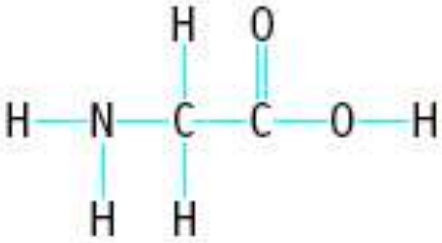
The sting of ants is due to the weak acid formic acid, $HCO_2H$. *(Gallo Images/@ CORBIS)*

# Acid and Bases



Aspirin is a weak acid that has been used as an analgesic for over 100 years. *(Charles D. Winters)*

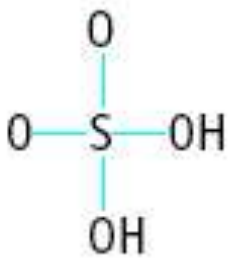



Glycine, $NH_2CH_2CO_2H$

Glycine is representative of the amino acids that are the basis of proteins. The $-CO_2H$ group is the acid portion of the molecule, and the $-NH_2$ group is the basic portion. *(Charles D. Winters)*

# Acid and Bases


Caffeine is a well known stimulant and a weak base. *(Charles D. Winters)*




A sea slug excretes the strong acid sulfuric acid in self-defense. *(Sharksong/ M. Kazmers/Dembinski Photo Associates)*

# *Acids*


Multiple definitions:

- Lewis
- Arrhenius
- Bronsted Lowry

Generally it's a chemical compound that produces a hydrogen ion concentration higher then pure water: $[H^+]$ or $[H_3O^+]$

# *Acids*

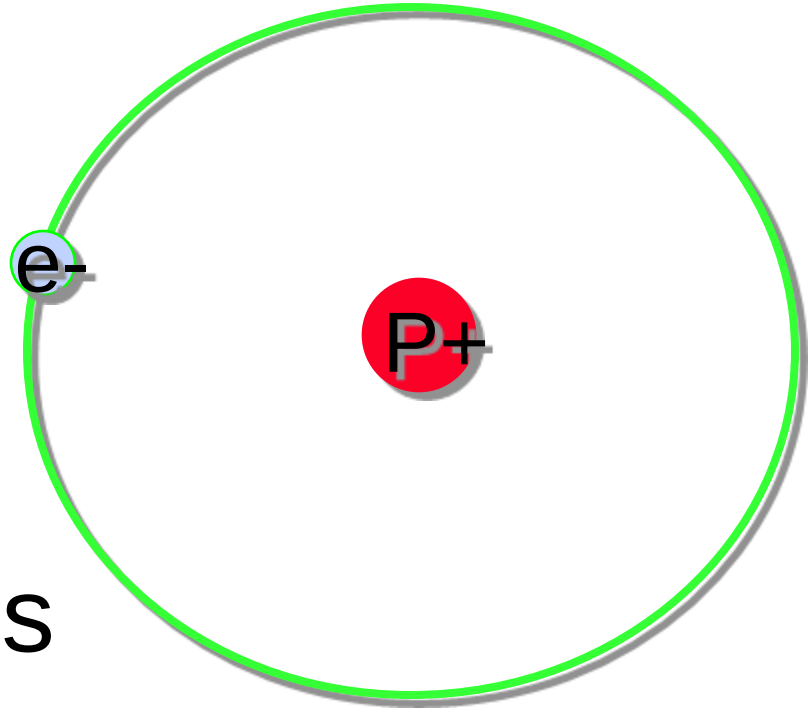
React with carbonates and bicarbonates to produce carbon dioxide gas

Have a sour taste. Vinegar is a solution of acetic acid. Citrus fruits contain citric acid.

# *Some Properties of Acids*

Produce $H^+$ (as $H_3O^+$ ions in water):

Call a "proton"




Taste sour

Corrode metals

# *Acid Nomenclature Review*

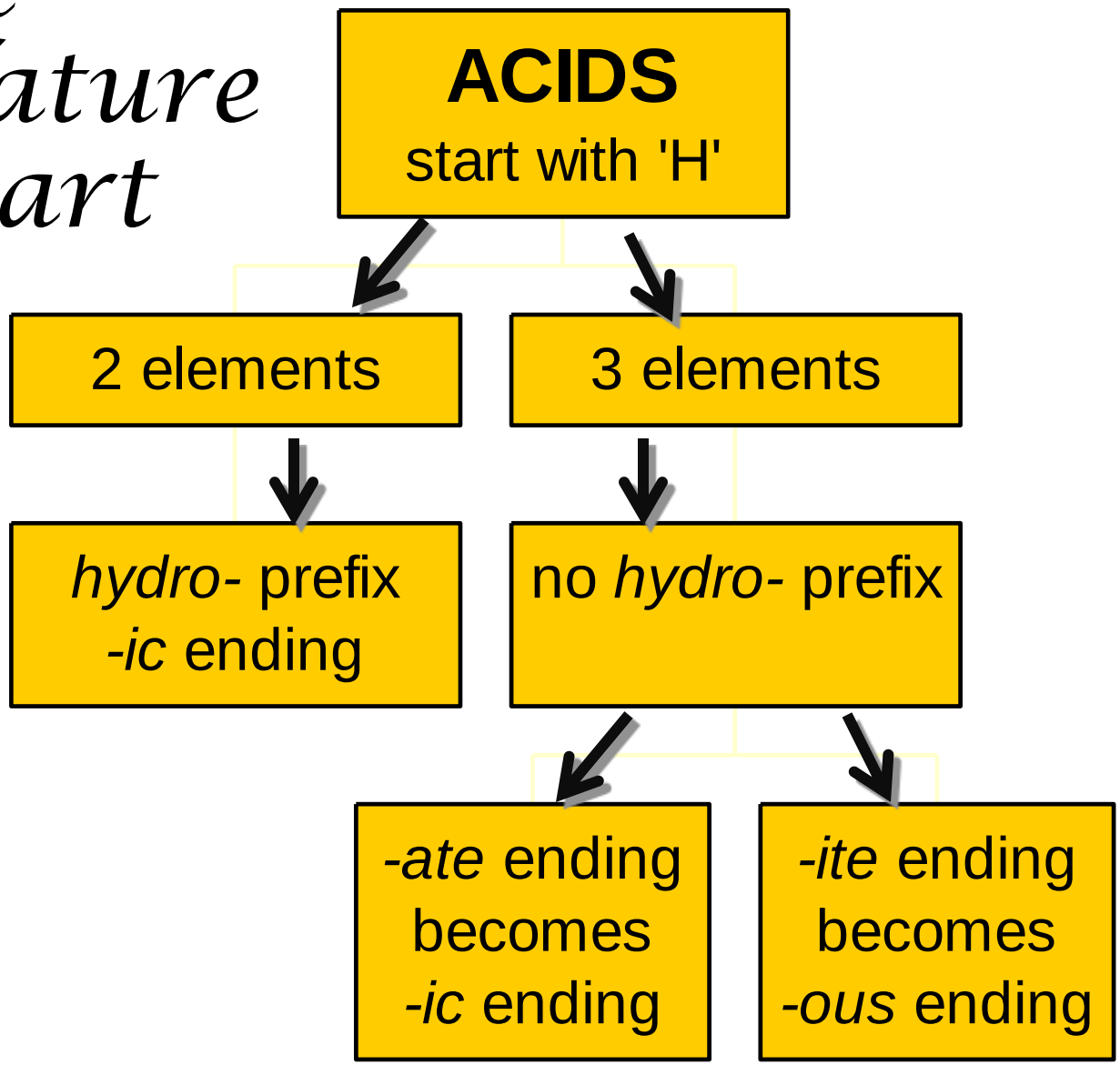
| | Anion Ending | Acid Name |
|---|---|---|
| Binary → | *-ide* | *hydro-*(stem)*-ic acid* |
| Ternary | *-ate* | (stem)*-ic acid* |
| Ternary | *-ite* | (stem)*-ous acid* |

# *Acid Nomenclature Review*

*An easy way to remember which goes with which…*

*"In the cafeteria, you ATE something ICky"*

# Acid Nomenclature Flowchart



# *Acid Nomenclature Review*

$HBr_{(aq)}$ $\Rightarrow$ hydrobromic acid

$H_2CO_3$ $\Rightarrow$ carbonic acid

$H_2SO_3$ $\Rightarrow$ sulfurous acid

# *Strong Acids*

Completely dissociates in water.

You will need to remember these three:

HCl

$H_2SO_4$

$HNO_3$

# *Name 'Em!*

HF

**HCl**

**$H_2SO_4$**

**$HNO_3$**

$HIO_3$

Which are strong acids?


# *Bases*

A chemical species that donates hydroxide ions ($OH^-$) or that accepts protons.

Have a bitter taste.

Feel slippery. Many soaps contain bases.

# *Some Properties of Bases*

Produce $OH^-$ ions in water

Taste bitter, chalky

Are electrolytes

Feel soapy, slippery

# *Name these Common Bases*

| | |
|---|---|
| **NaOH** | Drain cleaner |
| **KOH** | Liquid soap |
| **$Ba(OH)_2$** | Stabilizer for plastics |
| **$Mg(OH)_2$** | Milk of magnesia |
| **$Al(OH)_3$** | Maalox (antacid) |

# *Naming Bases*

Group I metals all form strong bases with hydroxide

Same name as chemical name

Ex. NaOH – Sodium hydroxide

List the rest of them (write their names and chemical formulas)

KNOW THEM

# *Recall…*

In your own words define:

- What an acid and base are,
- How can you distinguish them,
- How do you name them

# Bell Work
# 25.April.2017

**Name the following acids and bases:**

**CsOH**

**HBr**

**$HNO_2$**

**Write the correct formula for the following acid and bases**

**Ammonia**

**Acetic Acid**

**Carbonic Acid**

**Hydroiodic Acid**

EQ: What bases have you used today and how did they help you?

**Agenda:**
**Understanding the pH scale PHet Simulation**

Objective:

Following the lesson you will be able to name identify what the pH scale is, the relative difference in values on the scale and where common house hold solution register.

# Home Work

**Be able to label acids, bases, conjugate bases, and conjugate acids in a balance acid base reaction. You may use you text book to accomplish this.**

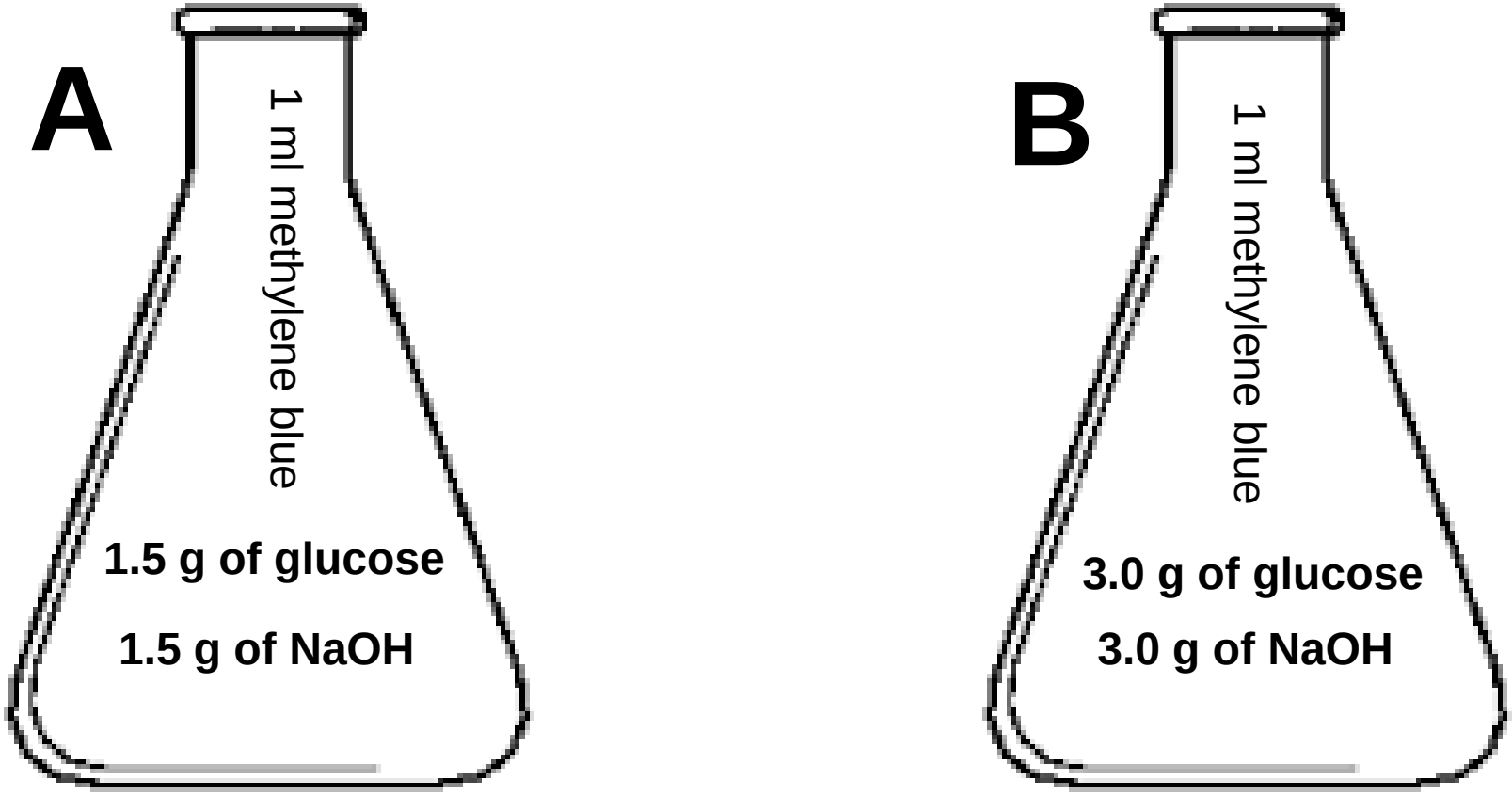
# Introduction to pH

**PhET Simulation on class website under labs**

**“Under Standing pH”**

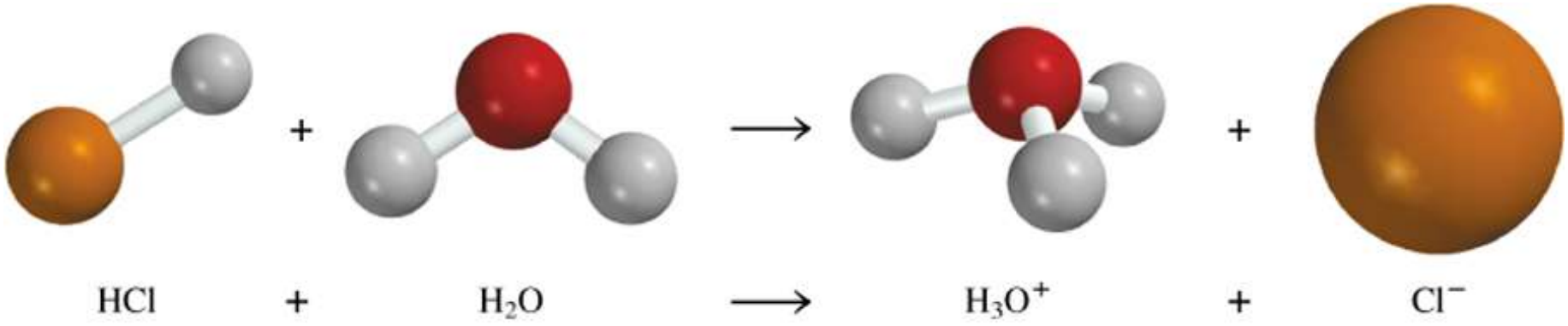
**Due 1May2017**

# Color Change Oxidation



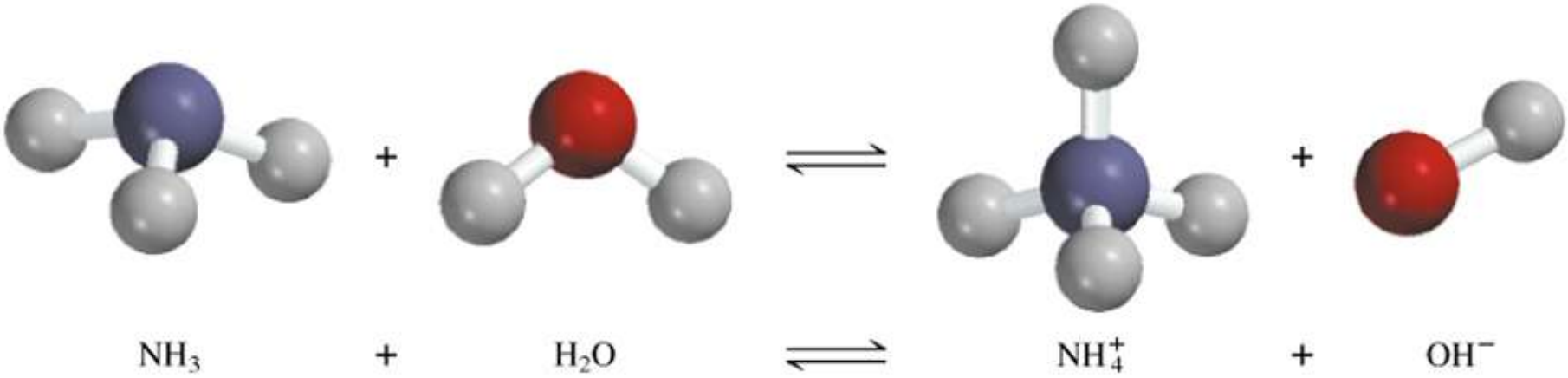

$$2CH_2OH–CHOH–CHOH–CHOH–CHOH–CHO + 1\ O_2 \rightarrow 2CH_2OH–CHOH–CHOH–CHOH–CHOH–COOH$$

*Arrhenius acid:* "is a substance that produces $H^+$ ($H_3O^+$) in water"




$HCl + H_2O \rightarrow H_3O^+ + Cl^-$

*Arrhenius base:* "is a substance that produces $OH^-$ in water"

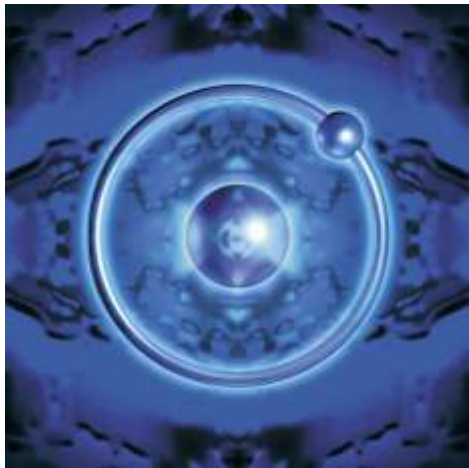



$$NH_3 + H_2O \rightarrow NH_4^+ + OH^-$$

# *Acid/Base Definitions*

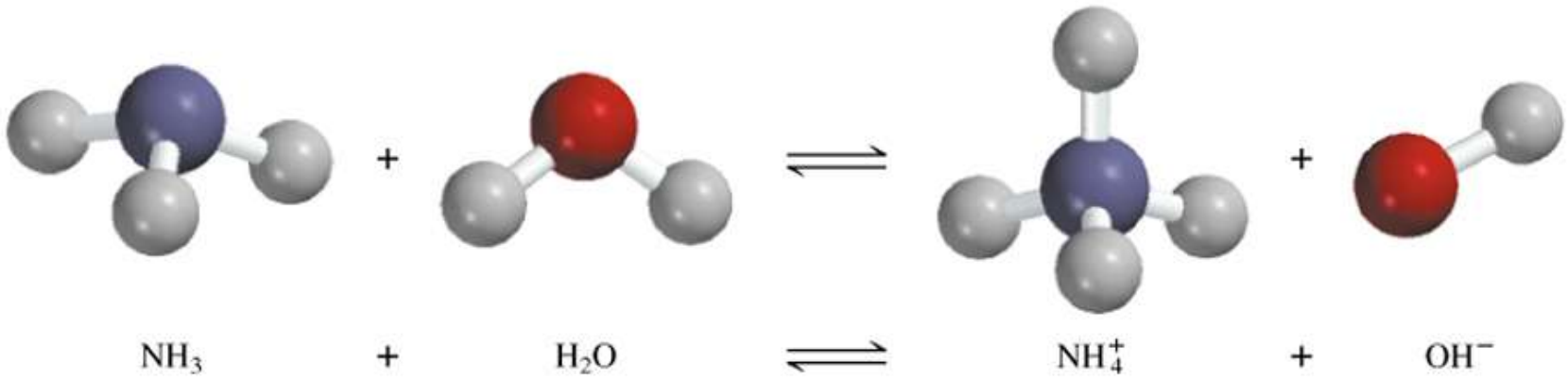
Definition #2 Brønsted – Lowry

- Acids – proton donor
- Bases – proton acceptor
- A “proton” is really just a hydrogen atom that has lost it’s $e^-$!



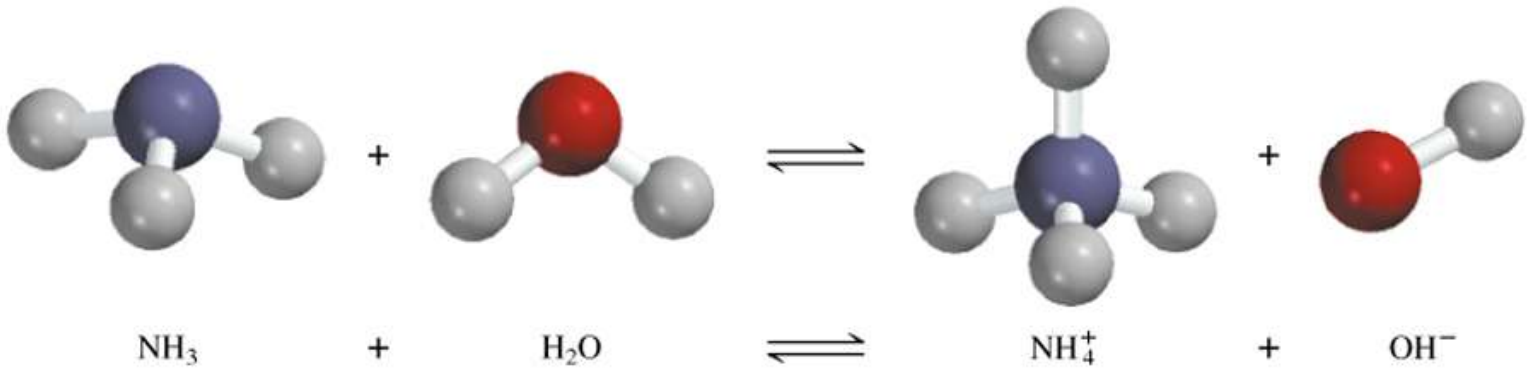
A Brønsted-Lowry acid is a proton donor

A Brønsted-Lowry base is a proton acceptor




**$NH_3$ + $H_2O$ → $NH_4^+$ + $OH^-$**

**base acid conjugate acid conjugate base**



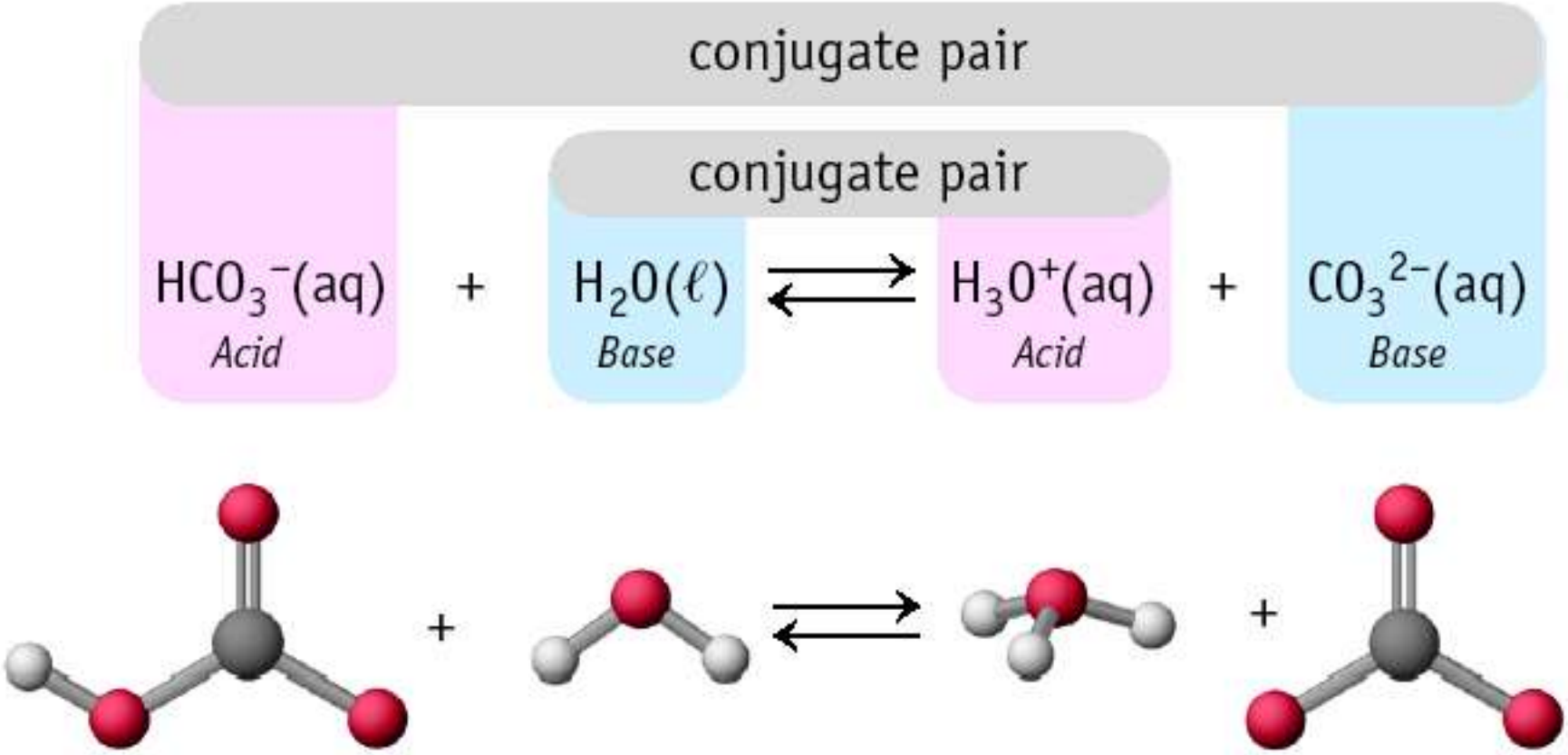

**$NH_3$ + $H_2O$ → $NH_4^+$ + $OH^-$**

**base** **acid** **conjugate acid** **conjugate base**

**conjugate acid:** substance formed when base gains a hydrogen ion

**conjugate base:** substance formed when an acid loses a hydrogen ion

# *Conjugate Pairs*



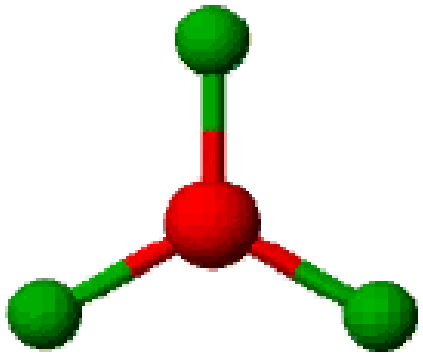
# Suggested Practice Homework

**Read 574-576, and #1-2**

# Acids & Base Definitions

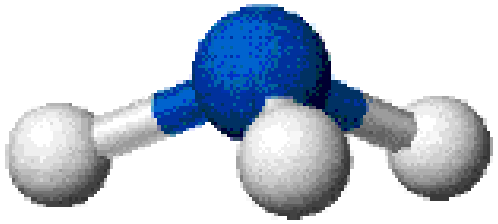
## Definition #3: Lewis

**Lewis acid - a substance that accepts an electron pair**



$BF_3$, the boron atom is surrounded by only three electron pairs.

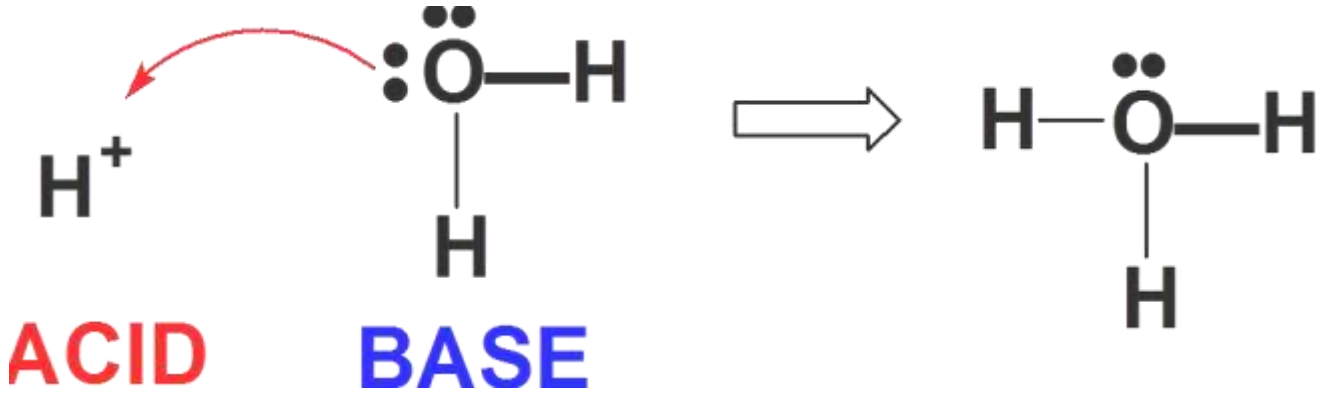
**Lewis base - a substance that donates an electron pair**



$NH_3$, the N atom has three bond pairs and one lone pair of electrons.

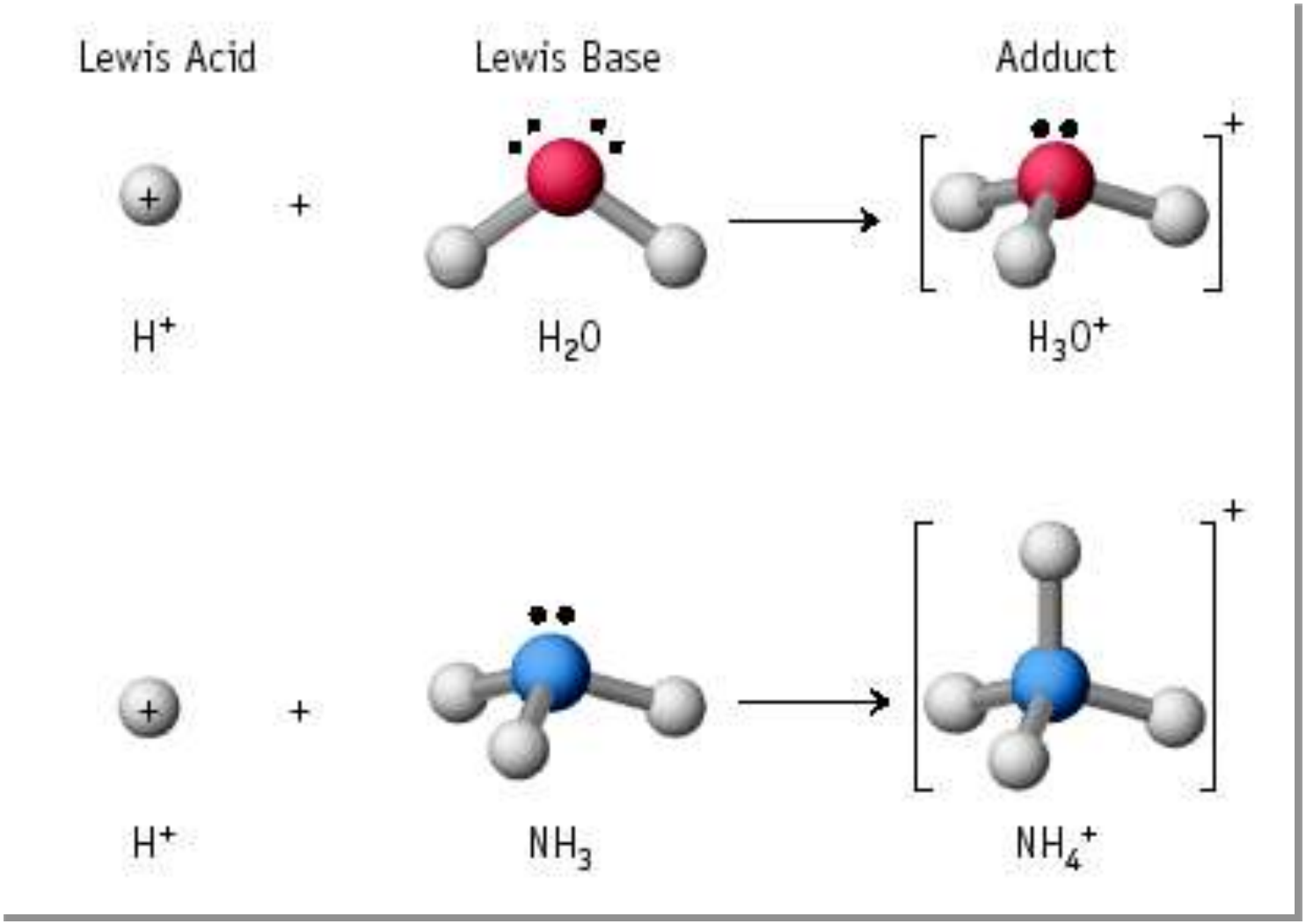
# *Lewis Acids & Bases*

**Formation of hydronium ion is also an excellent example.**




**Electron pair of the new O-H bond originates on the Lewis base.**

# *Lewis Acid/Base Reaction*



# *Learning Check!*

**Label the acid, base, conjugate acid, and conjugate base in each reaction:**

$HCl + OH^- \rightarrow Cl^- + H_2O$

$H_2O + H_2SO_4 \rightarrow HSO_4^- + H_3O^+$

# *For most Acid Bases Rxns*

The generic equation for most acid base rxn is:

$$HA + BOH \rightarrow BA + H_2O$$

You will get a salt and water out of an acid base rxn!

# *You try… write out the products:*

**$HA + BOH \rightarrow BA + H_2O$**

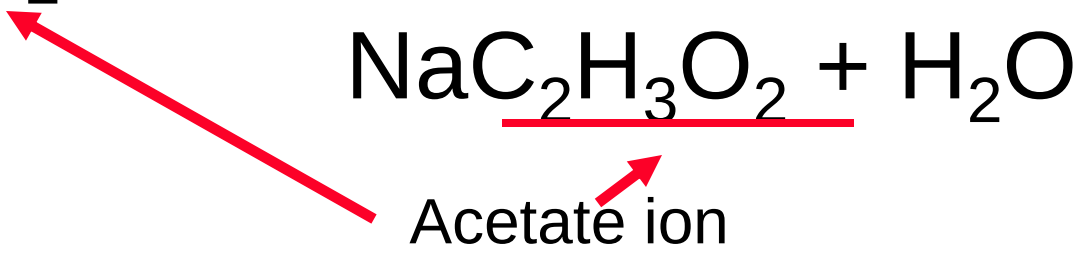
**You will get a salt and water out of an acid base rxn!**

1) $HCl + NaOH \rightarrow NaCl + H_2O$

2) $HNO_3 + KOH \rightarrow KNO_3 + H_2O$

3) Tricky $HC_2H_3O_2 + NaOH \rightarrow$

$NaC_2H_3O_2 + H_2O$



**What volume of a 1.420 *M* NaOH solution is required to titrate 25.00 mL of a 4.50 *M* $H_2SO_4$ solution?**

WRITE THE BALANCED CHEMICAL EQUATION!

$$H_2SO_4 + 2NaOH \longrightarrow 2H_2O + Na_2SO_4$$

volume acid $\xrightarrow{M\ \text{acid}}$ moles acid $\xrightarrow{\text{Mole Bridge}}$ moles base $\xrightarrow{M\ \text{base}}$ volume base

$$25.00\ \text{mL} \times \frac{4.50\ \text{mol}\ H_2SO_4}{1000\ \text{mL soln}} \times \frac{2\ \text{mol NaOH}}{1\ \text{mol}\ H_2SO_4} \times \frac{1000\ \text{ml soln}}{1.420\ \text{mol NaOH}} = 158\ \text{mL}$$

# Suggested Practice Homework

**Read 580, and #9-12**

# *Agenda*

***Acid base definitions***

***pH***

*Objective:*

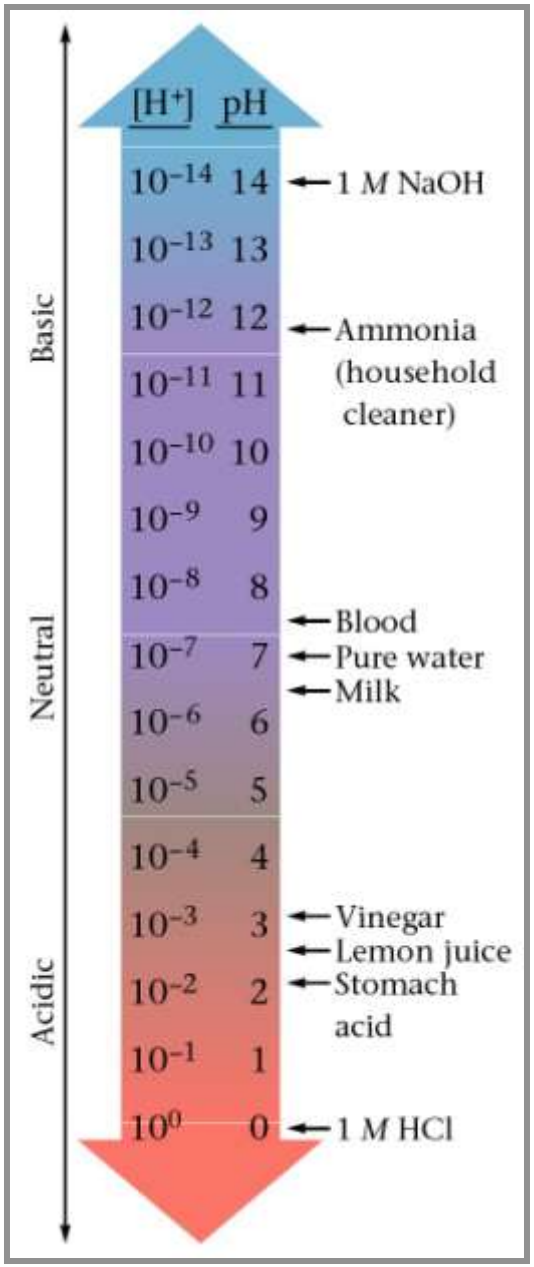
You will be able to describe the pH scale.

pH scale = way of expressing the strength of acids & bases. Instead of using very small #'s, we just use the NEGATIVE power of 10 on the Molarity of the $H^+$ (or $OH^-$) ion.

Under 7 = acid

7 = neutral

Over 7 = base



# pH of Common Substances


**Figure 5.17** **pH values of some common substances.** Here the "bar" is colored red at one end and blue at the other. These are the colors of litmus paper, commonly used in the laboratory to decide if a solution is acidic (litmus is red) or basic (litmus is blue). *(Charles D. Winters)*

# *Calculating the pH*

$$pH = - \log [H^+]$$

$$pH = - \log [H_3O^+]$$

(Remember that the [ ] mean Molarity)

Example: If $[H^+] = 1x10^{-10}$

$pH = - \log 1 \times 10^{-10}$

$pH = - (- 10)$

$pH = 10$

For a strong acid [H+] ~ the molarity of the solution

# *Calculating the pH*

$$pH = - \log [H+]$$

(Remember that the [ ] mean Molarity)

Example: If $[H^+] = 1.8 \times 10^{-5}$

$pH = - \log 1.8 \times 10^{-5}$

$pH = - (- 4.74)$

$pH = 4.74$

# *Try These!*

Find the pH of these:

1) A 0.15 M solution of Hydrochloric acid
2) A 3.00 $x10^{-7}$ M solution of Nitric acid
3) A 6.0M solution of Sulfuric acid

# *pH Cals. Solving for $[H^+]$*

If the pH of Coke is 3.12, $[H^+]$ = ???

Because pH = - log $[H^+]$ then

- pH = log $[H^+]$

Take antilog ($10^x$) of both sides and get

$10^{-pH} = [H^+]$

$[H^+] = 10^{-3.12} = 7.6 \times 10^{-4}$ M


*** to find antilog on your calculator, look for "Shift" or "2nd function" and then the "log" button

# Homework

**Finish pH Acid Base Practice up to Titrations**

# *Practice*

What is the pH of a solution with a proton concentration of 0.032 M?

What is the proton concentration in a solution with pH of 9.24?

# *pH Cals. Solving for H+*

**A solution has a pH of 8.5. What is the Molarity of hydrogen ions in the solution?**

$pH = - \log [H^+]$

$8.5 = - \log [H^+]$

$-8.5 = \log [H^+]$

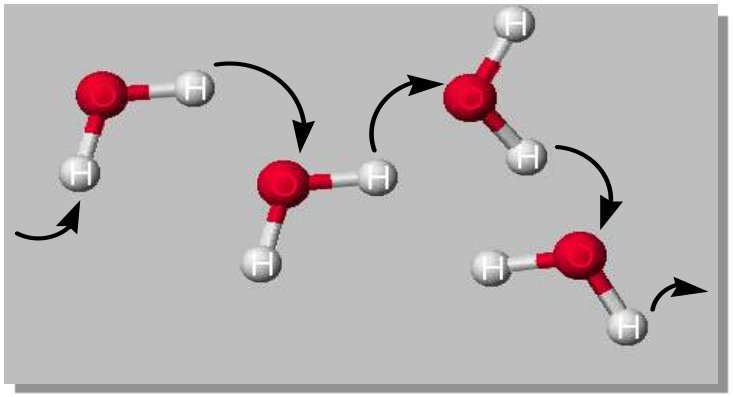
Antilog $-8.5$ = antilog $(\log [H^+])$

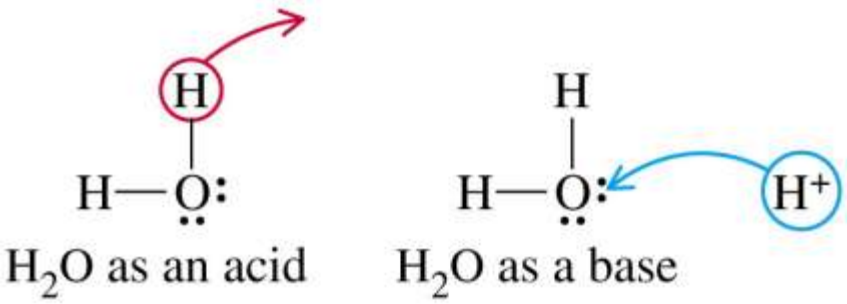
$10^{-8.5} = [H^+] \rightarrow$ **$3.16 \times 10^{-9}$ M**

# *More about Water*

$H_2O$ can act as both an ACID & a BASE.

In pure water there can be
AUTOIONIZATION






$H_2O$ as an acid  $H_2O$ as a base

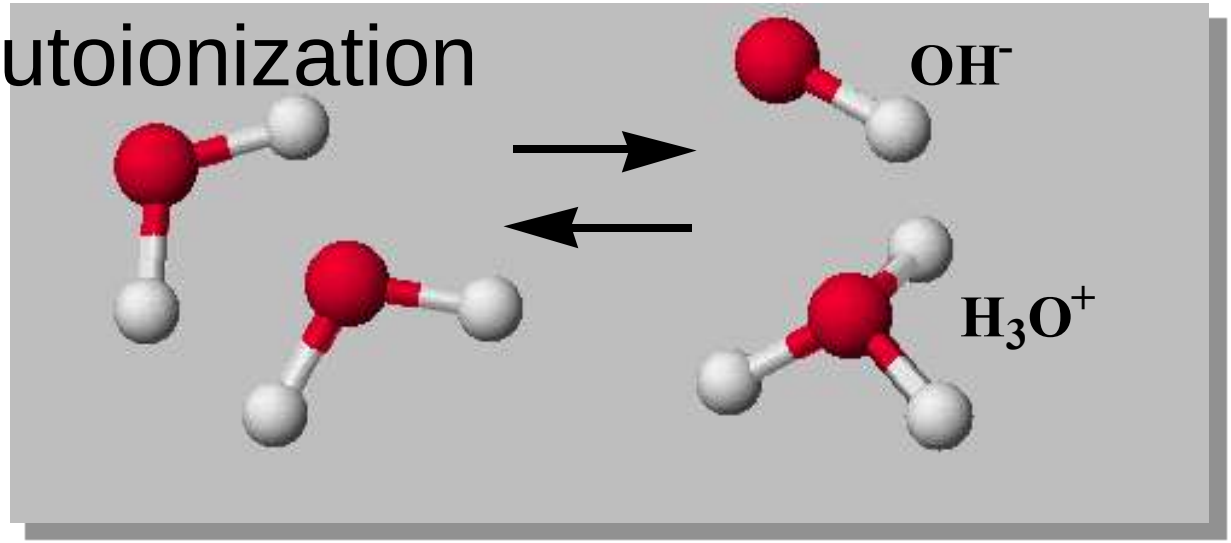
Equilibrium constant for water = $K_w$

$K_w = [H_3O^+]\,[OH^-] =$

$K_w = [H^+]\,[OH^-] =$

$1.00 \times 10^{-14}$ at 25 °C

# *More about Water*




$K_w = [H_3O^+]\,[OH^-] = 1.00 \times 10^{-14}$ at 25 $^oC$

In a neutral solution $[H_3O^+] = [OH^-]$

so $K_w = [H_3O^+]^2 = [OH^-]^2$

and so $[H_3O^+] = [OH^-] = 1.00 \times 10^{-7}$ M

# *pOH*

Since acids & bases are opposites, pH and pOH are opposites!

pOH does not really exist, but it is useful for changing bases to pH.

$$\underline{pOH = - \log [OH^-]}$$

Since pH and pOH are on opposite ends of scale,

$$pH + pOH = 14$$

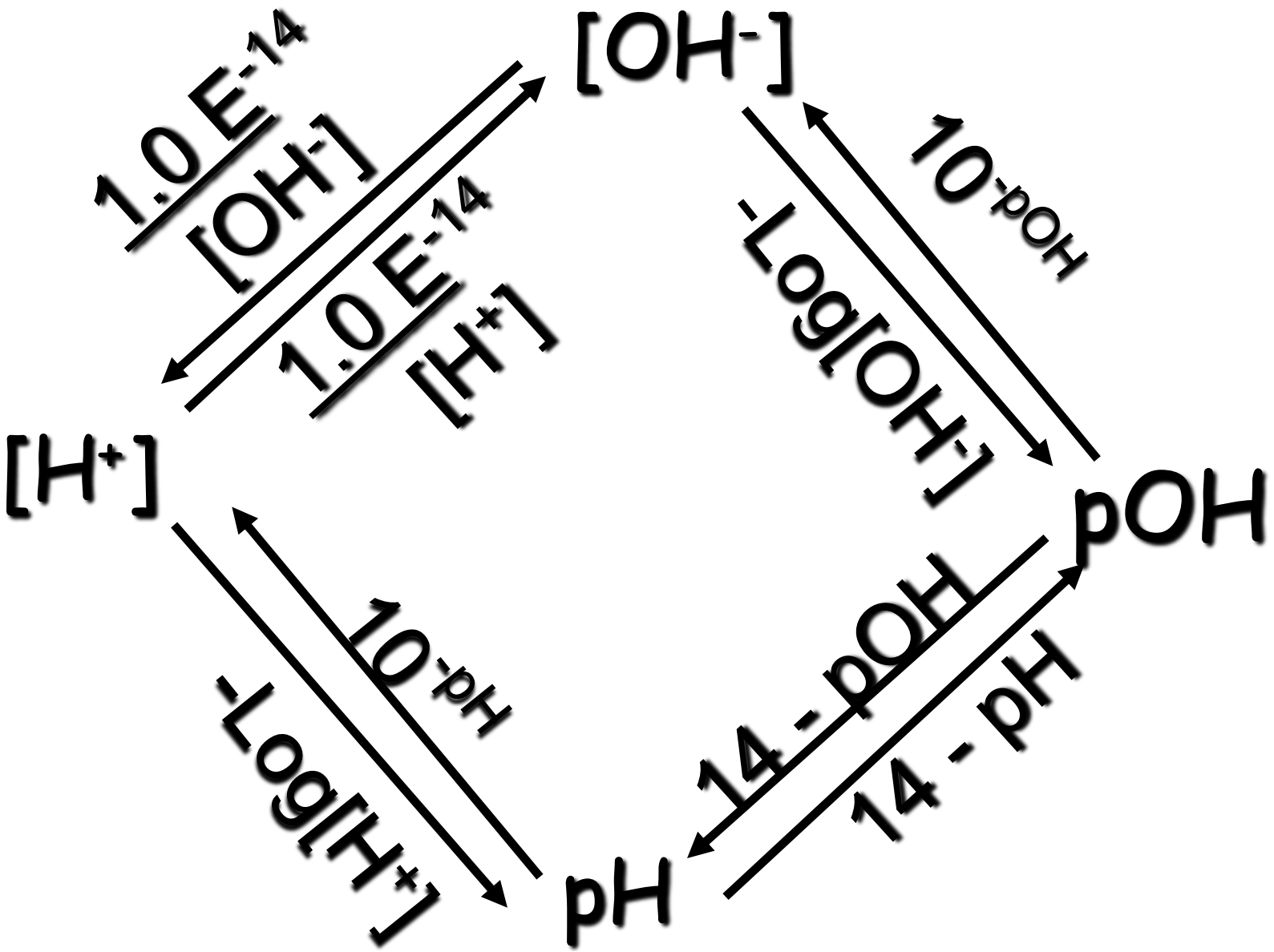
# $\mathcal{K}_w$

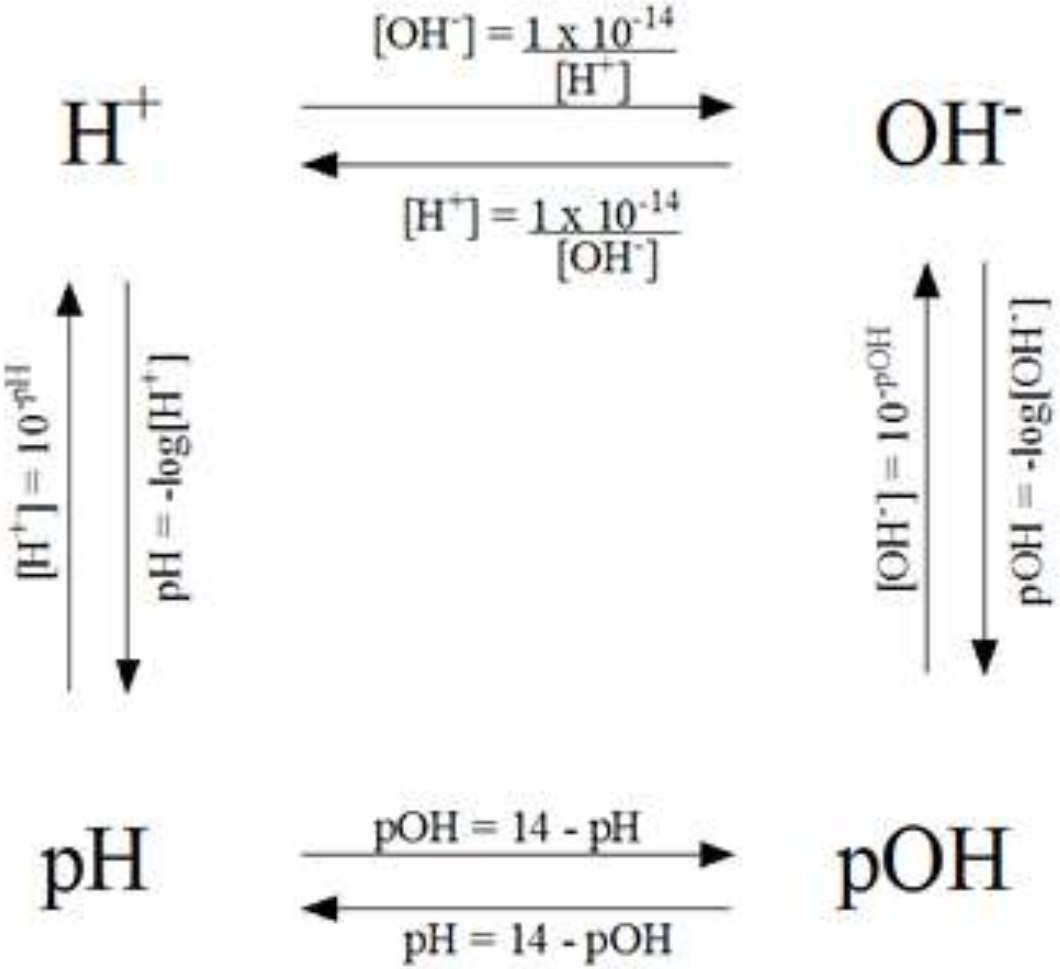
Water dissociation constant; $K_w$.

$K_w = 1.0 \times 10^{-14}$

$K_w = [H^+][OH^-]$

$1.0 \times 10^{-14} = [H^+][OH^-]$


[OH-]
[H+]
pOH
pH
1.0 E-14 / [OH-]
1.0 E-14 / [H+]
10-pOH
-Log[OH-]
10-pH
-Log[H+]
14 - pOH
14 - pH


H+
OH-
pH
pOH
[OH-] = 1 x 10-14 / [H+]
[H+] = 1 x 10-14 / [OH-]
[H+] = 10-pH
pH = -log[H+]
[OH-] = 10-pOH
pOH = -log[OH-]
pOH = 14 - pH
pH = 14 - pOH

# *Bell Work 1.May.2017*

A student dilutes concentrated hydrochloric acid to make two solutions:
(a) 3.0 *M*
(b) 0.0024 *M*.

Calculate the $[H^+]$, pH, $[OH^-]$, and pOH of the two solutions at 25°C.

# EQ:
# Why is pH so misunderstood?

## Objective

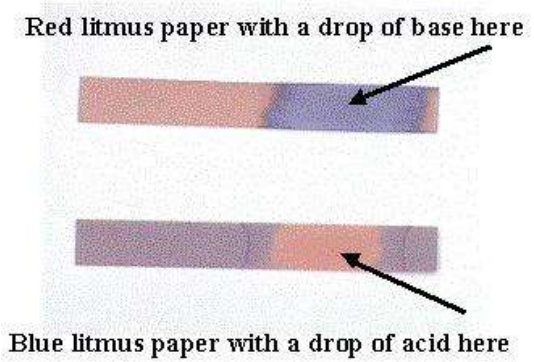
**Are you up to speed?**

**pH, [H+], etc. calculation Recap**

# *pH testing*

There are several ways to test pH

- Blue litmus paper (red = acid)
- Red litmus paper (blue = basic)
- pH paper (multi-colored)
- pH meter (7 is neutral, <7 acid, >7 base)
- Universal indicator (multi-colored)
- Indicators like phenolphthalein
- Natural indicators like red cabbage, radishes




# *Paper testing*

Paper tests like litmus paper and pH paper

- Place a drop of the solution from the end of the stirring rod onto a piece of the paper
- Read and record the color change. Note what the color indicates.
- You should only use a small portion of the paper. You can use one piece of paper for several tests.

# *pH paper*

## Behavior of Salts in Water

**Table 18.8** The Behavior of Salts in Water

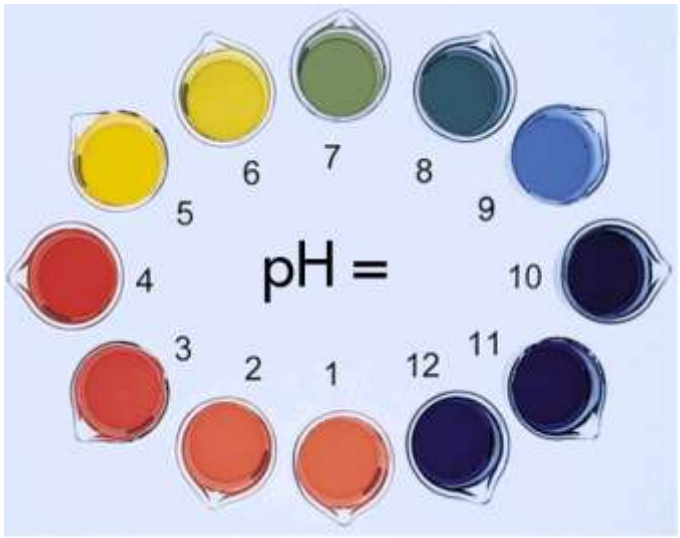
| Salt Solution (Examples) | pH | Nature of Ions | Ion That Reacts with Water | |
|---|---|---|---|---|
| Neutral [NaCl, KBr, $Ba(NO_3)_2$] | 7.0 | Cation of strong base<br>Anion of strong acid | None |  |
| Acidic [$NH_4Cl$, $NH_4NO_3$, $CH_3NH_3Br$] | <7.0 | Cation of weak base<br>Anion of strong acid | Cation |  |
| Acidic [$Al(NO_3)_3$, $CrCl_3$, $FeBr_3$] | <7.0 | Small, highly charged cation<br>Anion of strong acid | Cation |  |
| Basic [$CH_3COONa$, KF, $Na_2CO_3$] | >7.0 | Cation of strong base<br>Anion of weak acid | Anion |  |

# pH meter

- Tests the voltage of the electrolyte
- Converts the voltage to pH
- Very cheap, accurate
- Must be calibrated with a buffer solution

# pH indicators

- **Indicators are dyes that can be added that will change color in the presence of an acid or base.**
- **Some indicators only work in a specific range of pH**
- **Once the drops are added, the sample is ruined**
- **Some dyes are natural, like radish skin or red cabbage**

# Bell Work 2May2017

**Write the balance equation for sodium hydroxide reaching with hydrochloric acid.**

If 10.0mL of sodium hydroxide is reacted (neutralized) with 25.0mL of 0.05M hydrochloric acid, what is the concentration of the sodium hydroxide?

# EQ:
# Why is pH so misunderstood?

## Objective

**You will be able to set up a burette and dispense specific quantities of analyite to a reaction flask**

# Titrations; Setting up Burette

1. Attach to ring stand using burette clamp

2. Open burette and rinse with DI water into a waste beaker.

3. Close burette after all DI water and drained through run2-5mL of through burette to coat sides.

4. Close burette and load titrant, run just enough titrant through burette to remove all air bubbles from spout.

**Titrant; what you know (known concentrations)**

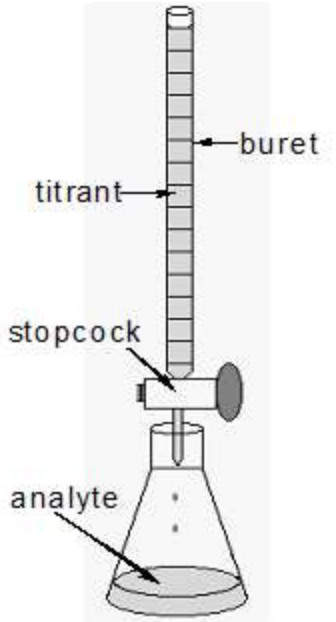


Figure 1: Titration Setup

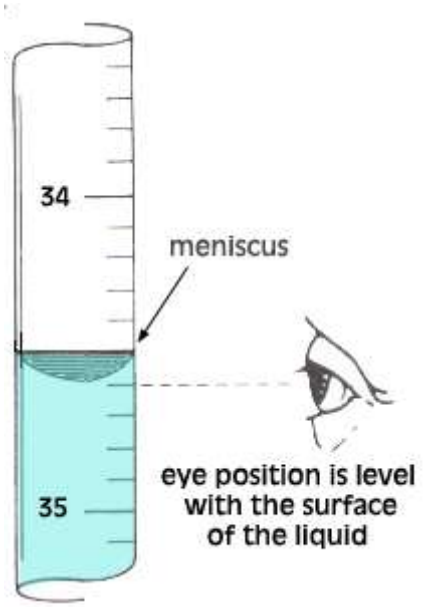
**Analyte; what you are trying to find**

# *Titrations, Reading a Burette:*

Make sure burette is level.

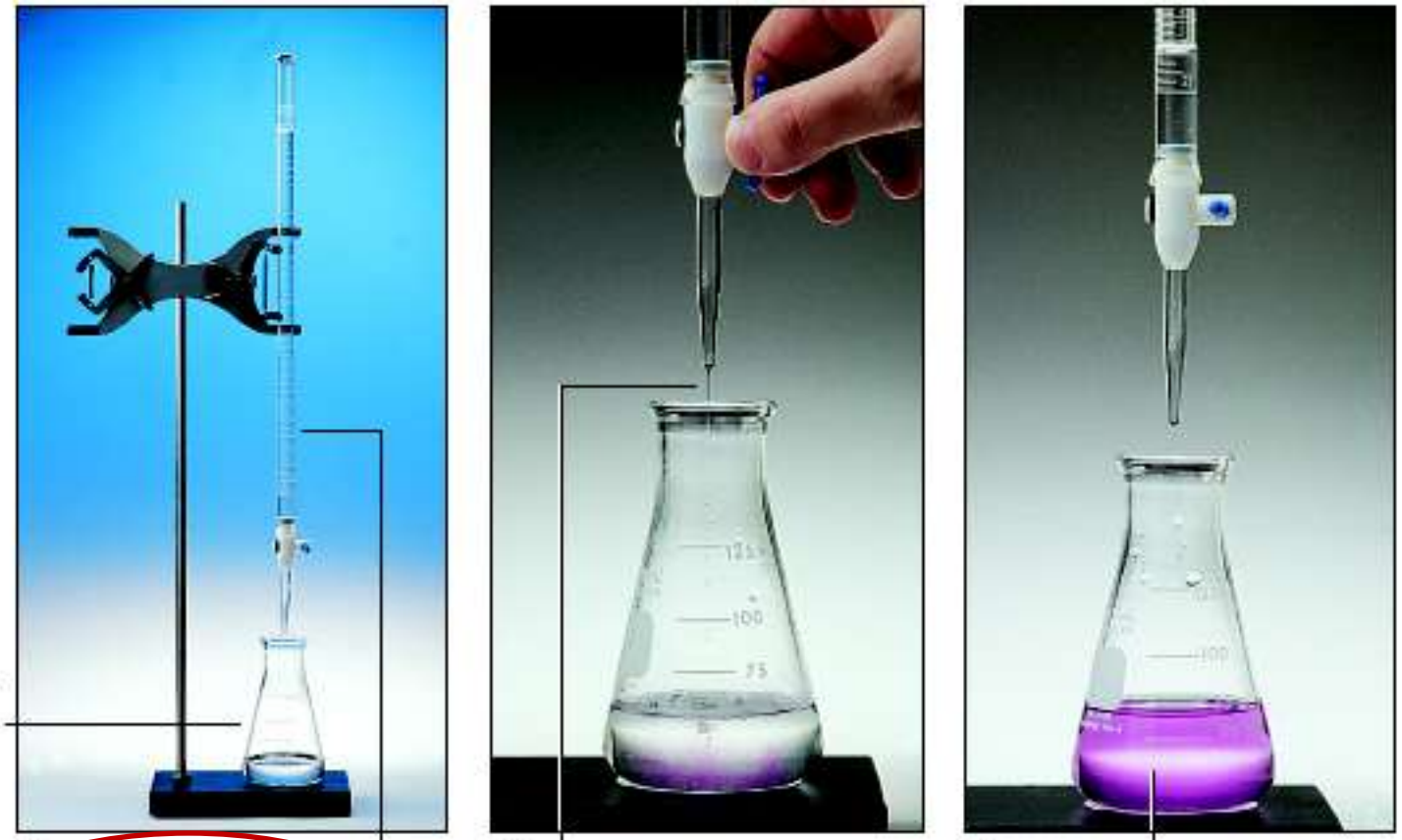
5. Record initial volume by reading bottom of meniscus

6. After titration is complete, read final volume and record.


| | **Trial 1** | **Trail 2** |
|---|---|---|
| **Vol $_{initial}$** | | |
| **Vol $_{Final}$** | | |
| **Vol $_{dispensed}$** | | |

# Setup for titrating an acid w/ a base



Flask containing aqueous solution of sample being analyzed

(a)
50-mL buret containing aqueous NaOH of accurately known concentration

(b)
A solution of NaOH is added slowly to the sample being analyzed. The sample is mixed.

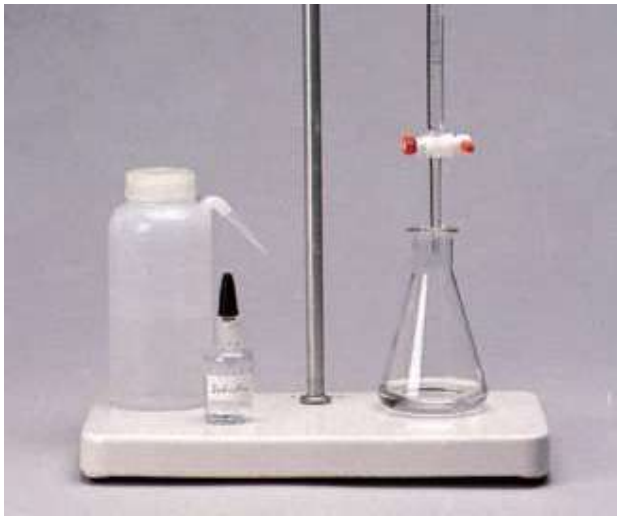
(c)
When the amount of NaOH added from the buret exactly equals the amount of $H^+$ supplied by the acid being analyzed, the dye (indicator) changes color.

# *Titrations*

In a *titration* a solution of accurately known concentration is added gradually added to another solution of unknown concentration until the chemical reaction between the two solutions is complete.

*Equivalence point* the point at which the reaction is complete

*Indicator* – substance that changes color at (or near) the equivalence point



Slowly add base to unknown acid UNTIL

the indicator changes color

# *Titrations*

I. Practice rinsing burette and setting up for use.

II. Load burette with titrant (just water today)

III. Add known amount of analyte to a Erlenmeyer Flask (just water today)

IV. Each person: Practice dispensing titrant in amounts of 10ml, 5mL, 2mL, 1mL, and 0.1mL.

***V. Clean up, always leave burette in the open position and make sure you have rinsed 2-3x with DI water!***

# Intro to Titrations

1. Add solution from the buret (base).
2. Reagent (base) reacts with compound (acid) in solution in the flask.
3. Indicator shows when exact stoichiometric reaction has occurred. [Acid] = [Base])

This is called NEUTRALIZATION.

# *Acid Base Titration Calculations*

Recall our dilution formula

$$M_1V_1 = M_2V_2$$

M = Molarity (mol/L)

V = Volume (L)

Think of it like this:

$$M_{acid}V_{acid} = M_{base}V_{base}$$

# Final FWUSD STEM Lecture,

*Who: Dr. Everett Schlawin*
*What: The James Webb Space Telescope and the Closest Yet Looks at New Worlds*
*When: Tuesday, May 2nd from 3:45pm-5:00pm*
*Where: Flowing Wells Board Room (note location change)*

**Talk Summary:** The James Webb Space Telescope (JWST) is coming to a Lagrangian point near you! Set to launch in October 2018, JWST will be the largest ever space telescope. It will explore the darkest and deepest parts of the Universe as well as inspect exoplanets to levels that have never been achieved before. I will discuss the status of the telescope, the University of Arizona-led infrared camera called NIRCam and how JWST will explore new planets.

Extra Credit (5points) if you type up a 0.5-1.0page summery of the lecture including what you learned and how it applies to your life. Due to Mr. Golden by 4May2017

# *Acid Base Rxn Titration*

**$HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$**

**acid base**

**Carry out this reaction using a TITRATION.**